AGENCY ~~RESPONSE~~APPROVAL ~~REVIEW~~ DRAFT

Subsurface Sediment Coring Field Sampling Plan

Portland Harbor Pre-Remedial Design Investigation and Baseline Sampling

Portland Harbor Superfund Site

AECOM Project Number: 60554349
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CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Kenneth Tyrrell

~~March 30~~April 3~~January 18~~, 2018

Kenneth M. Tyrrell
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Date

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Commented [A2]: *Note to EPA: the word "blind" has been removed from blind field duplicate*

Commented [A3]: *Note to EPA: Added Atterberg Limits testing information to table.*

Commented [A4]: *Note to EPA: field processing lab location added to map.*

Commented [A5]: *Note to EPA: Changed to the Notes section in each figure: Existing cores that are projected on the cross section may appear above or below the mudline elevation line(s); these are artifacts of the projection. The mudline elevations in the lower panel are drawn from the bathymetric contours in the upper panel.*

Commented [A6]: *Note to EPA: Minor updates to equipment checklist to address EPA comment#23. ASTM Visual-Soil Classificatio Method added to Appendix A-3.*

Commented [A7]: *Note to EPA: Appendix B edited to add Appendices B-2 through B-5.*

ACRONYMS AND ABBREVIATIONS

~~NAD~~	~~North American Datum~~
°C	degrees Celsius
AECOM	AECOM Technical Services
ALS	ALS Environmental
Alt F Mod	Alternative F Modified SMA footprint
Anchor	Anchor Environmental LLC
ASAOC	Administrative Settlement Agreement and Order on Consent
ASTM	American Society for Testing and Materials
bml	below mudline
COCs	contaminants of concern
CRD	Columbia River Datum
CSM	Conceptual Site Model
D/F	dioxin/furans
D/U Reach	Downtown/Upriver Reach
DDT	dichlorodiphenyltrichloroethane
DDx	DDT and its derivatives
DGPS	differential global positioning system
DQMP	Data Quality Management Plan
DQOs	Data Quality Objectives
EPA	United States Environmental Protection Agency
FC	Field Coordinator
FMD	future maintenance dredge area
FS	feasibility study
FSP	Field Sampling Plan
ft	foot/feet
ft/lbs	feet per pound
Geosyntec	Geosyntec Consultants, Inc.
GIS	geographic information system
Gravity	Gravity Marine Services
ID	identification number
IDW	investigation-derived waste
Integral	Integral Consulting, Inc.
LWG	Lower Willamette Group
MHW	mean high water
NAD83 (2011)	North American Datum of 1983 National Adjustment of 2011
NAPL	non-aqueous phase liquid

NAVD88	North American Vertical Datum of 1988
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PDI	Pre-Remedial Design Investigation
PHSS	Portland Harbor Superfund Site
PID	photoionization detector
PRD	Portland River Datum
Pre-RD AOC Group	Pre-Remedial Design Agreement and Order on Consent Investigation Group
Pre-RD	Pre-Remedial Design
PSEP	Puget Sound Estuary Program
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RAL	r~~R~~emedial a~~A~~ction l~~L~~evel
RI	remedial investigation
RM	river mile
ROD	Record of Decision
SC	sediment core
Site	Portland Harbor Superfund Site
SMA	sediment management area
SOPs	Standard Operating Procedures
SOW	Statement of Work
SPCS	State Plane Coordinate System
TestAmerica	TestAmerica Laboratories
TOC	total organic carbon
USACE	United~~.~~ States~~.~~ Army Corps of Engineers
USGS	United ~~.~~States~~.~~ Geological Survey

1. INTRODUCTION

The Record of Decision (ROD) described a post-ROD sampling effort for the Portland Harbor Superfund Site (Site or PHSS; Figure 1) located in Portland, Oregon, to delineate and better refine the sediment management area (SMA) footprints, refine the Conceptual Site Model (CSM), determine baseline conditions, and support remedial design (United States Environmental Protection Agency [EPA] 2017a). Geosyntec Consultants, Inc. (Geosyntec), and AECOM Technical Services (AECOM) submitted a detailed Work Plan for Pre-Remedial Design Investigation and Baseline Sampling (PDI) on behalf of a group of industrial parties called the Pre-Remedial Design Agreement and Order on Consent Investigation Group (Pre-RD AOC Group). On December 19, 2017, EPA entered into an Administrative Settlement Agreement and Order on Consent (ASAOC) with the Pre-RD AOC Group to conduct the PDI studies at the Site (EPA 2017b). The ASAOC includes a Statement of Work (SOW) and the PDI Work Plan (as an attachment to the SOW), which generally describe the agreed upon field investigation activities, data analyses, schedule, and deliverables for the PDI.

These PDI studies are a foundational step in what will be a multi-phase effort to update current conditions from the collection of data during the remedial investigation (RI)/feasibility study (FS). The RI/FS was initiated by a group of potentially responsible parties known as the Lower Willamette Group (LWG) and completed by EPA in 2016 (EPA 2016a, 2016b). The RI consisted of three rounds of data collection, including surface and subsurface sediment, shoreline/nearshore soils, surface water, sediment traps, porewater, fish tissue, and other media from 2001 through 2007.

This Field Sampling Plan (FSP) was prepared to support the subsurface sediment sampling outlined in the PDI Work Plan (Geosyntec 2017) and the project Quality Assurance Project Plan (QAPP) (AECOM and Geosyntec 2018a). To the extent practicable, previously approved FSPs and standard operating procedures (SOPs) from the RI will be referenced.

1.1 Project Setting

The PHSS is located in Portland, Oregon, on the lower Willamette River immediately downstream of the urban downtown area from river mile (RM) 1.9 upstream to 11.8 and covers 2,190 acres. There are two reaches located immediately upstream of the Site. The Downtown Reach, which includes the urbanized area of downtown Portland, is defined by EPA as extending from RM 11.8 to RM 16.6. EPA defines the Upriver Reach as extending from RM 16.6 to RM 28.4. Collectively, RM 11.8 to RM 28.4 is referred to as the Downtown/Upriver Reach (D/U Reach).

The bathymetry elevation for most of the Site is from -30 to -50 feet (ft) Columbia River Datum (CRD) and is dominated by the authorized federal navigation channel (EPA 2017a). This channel, extending nearly bank-to-bank in some areas, doubles the natural depth of the river and allows transit of large ships into the active harbor; the PHSS serves as a major shipping route for containerized and bulk cargo. Elevations in the federal navigation channel are generally -40 to -50 ft CRD, and the authorized depth is -40 ft CRD (or about -35 ft North American Vertical Datum of 1988 [NAVD88]). The CRD vertical datum is used by the United~~.~~ States~~.~~ Geological Survey (USGS) and United~~.~~ States~~.~~ Army Corps of Engineers (USACE); however, the primary vertical datum used for the PDI studies will be NAVD88.[1] The USGS gauging stations is located at the Morrison Bridge at RM 12.8; river levels recorded by that gauge are reported in Portland River Datum (PRD). Additional shipping and berthing areas were identified in the ROD as future maintenance dredge (FMD) areas with potential maintenance dredging requirements.

The remedy selected in the ROD (EPA 2017a), called the Alternative F Modified SMA footprint (Alt F Mod), identified 394 acres of engineered remediation with a combination of remedial technologies. The PDI subsurface sediment sampling activities are focused on refining the horizontal and vertical extent of contamination in these areas, especially the SMA areas targeted for dredging or partial dredging/capping. A total of 90 PDI cores are proposed to reduce this uncertainty. In addition, a surface sediment grab sample will be collected from each deep, in-water core location per protocols outlined in the Surface Sediment Sampling FSP.

Subsurface sediment samples will be analyzed for the focused contaminants of concern (COCs), which include dichlorodiphenyltrichloroethane (DDT) and its derivatives (DDx), polychlorinated biphenyls (PCBs, as Aroclors), polycyclic aromatic hydrocarbons (PAHs), and dioxin/furans (D/F).

1.2 Data Quality Objectives

Data Quality Objectives (DQOs) for subsurface sediment sampling are detailed in Table 3 of the project QAPP and are consistent with the PDI Work Plan (Geosyntec 2017). Criteria for acceptable laboratory quality assurance/quality control (QA/QC) are described in Section 3.3 of the project QAPP, and the analytical suite for the samples is presented in Table 2a in the project QAPP (AECOM and Geosyntec 2018a). As stated in the PDI Work Plan (attached to the ASAOC), the goal of the subsurface sampling effort is to refine the horizontal and vertical extent of contamination greater than the remedial action levels (RALs) at depth for the purpose of supporting the 30% design, to refine the CSM for remedial design purposes, and to refine the dredge volumes for 30% design cost estimation.

~~The purpose of the subsurface sampling effort is to refine the CSM for the Site, help reduce the uncertainty and refine the SMA footprints, and help evaluate concentration changes over time for~~

[1] CRD is used as the nautical chart datum for the lower Willamette River, using a reference plane established by the USACE in 1912. Because this datum is based on water elevations throughout the river, CRD is not a fixed/level datum but slopes upward as one moves upstream. Therefore, the NAVD88 fixed vertical datum will be the primary datum used in the PDI studies. The difference between the two datums is about 5.2 vertical ft within the Site. For reference, at RM 1.3 the difference is 5.4 ft, and at RM 12.8 the difference is 4.6 ft.

~~focused COCs that have remedial action levels (RALs). Subsurface sediment sampling will be conducted in targeted areas within or along the boundaries of SMAs that have limited subsurface data coverage with the purpose of refining the active footprint boundaries of the Alt F Mod SMAs and collect data to support the allocation process. PDI subsurface data will be collectively viewed with historical RI subsurface data, new PDI bathymetry, and new PDI surface sediment data to update the CSM relative to subsurface conditions.~~

2. SAMPLING DESIGN AND APPROACH

A total of 90 core locations, presented in Figures 2a through 2f, have been selected for the PDI study to refine the spatial extent (horizontal and vertical) of the Alt F Mod active SMA remedial footprint. Methods for subsurface sediment sampling are generally consistent with EPA-approved sampling plans from the RI (Integral Consulting, Inc. [Integral] 2002, 2004, 2006), EPA guidance on collecting and processing sediment data (EPA 2014), and Puget Sound Estuary Program (PSEP) protocols (PSEP 1986).

2.1 Previous LWG RI/FS Subsurface Sediment Coring

The LWG completed three rounds of field sampling between 2002 and 2008 for the RI/FS. Subsurface sediment core sampling is summarized below.

- Subsurface samples were collected during the Round 2 field sampling event (2004-2005) in two phases: Round 2A and Round 2B (Integral and Anchor Environmental LLC [Anchor] 2005; Integral 2005).
  - During Round 2A coring between September and November 2004, a total of 218 cores were collected from 200 locations within RM 2 and RM 10. A total of 717 subsurface sediment samples were submitted for laboratory analyses.
  - During Round 2B coring in October 2005, a total of 181 subsurface samples were collected from 42 locations between RM 3.5 to RM 10.
- Subsurface sediment samples were collected during the Round 3 field sampling event (2007-2008) in two phases: Round 3A and Round 3B (Integral 2007, 2008).
  - During Round 3A coring in January and February 2007, subsurface samples were collected upstream between RM 9.5 and RM 12 and downstream of the Site between RM 0.9 and RM 1.9. A total of 24 sediment cores were collected from 18 locations in the upstream and downstream reaches combined, and 106 subsurface sediment samples were submitted for laboratory analyses.
  - During Round 3B coring between November 2007 and January 2008, a total of 94 subsurface cores were collected from 88 locations within three reaches: 1) the Site and slightly upriver of the Site between RM 2 and RM 12.2;~~,~~ 2) the upper reach of

the Multnomah Channel;~~,~~ and 3) upriver between RM 15.3 and RM 26. A total of 244 subsurface sediment samples were submitted for laboratory analyses.

Post RI/FS sampling was conducted by multiple parties along the Willamette River between RM 1.9 and RM 11.8. These investigations were supplementary to the RI/FS and are discussed in the PDI Work Plan. Details on core locations were not available for many of these studies, and they were not used in locating cores for this PDI. As additional details on these post-RI/FS studies become available, information will be included in the data analysis and reporting phases.

2.2 Sediment Core Location Rationale

Proposed and historical core locations are presented ~~on~~in Figures 3a through 3h. Placement of the 90 proposed core locations were based on the visual assessment of subsurface contamination using 250- to 300-ft distance as a general guidance to the next nearest coring location. In some cases, stations will be re-occupied to determine the vertical extent of contamination, or a new core will be collected in an SMA where none previously existed. Proposed core locations and depths were selected to target spatial gaps from the RI subsurface data. Rationale for placement of PDI cores were based on the following concepts relative to the subsurface:

- **Spatial Resolution**. For portions of SMAs with limited subsurface data, cores were located to achieve an approximately 250 to 300 ft spacing distance to the next nearest historical coring location within an SMA, to refine the spatial resolution between data and provide improved understanding of subsurface concentration gradients between samples.
- **Horizontally Unbounded.** For spatial boundaries of SMAs with limited historical core coverage near the boundaries of a cleanup footprint, especially in dredge areas, cores were located to refine the horizontal extent of subsurface data in dredge footprints where SMAs are horizontally unbounded. This particularly applies to subsurface volume estimates toward the navigation channel.
- **Vertically Unbounded**. For portions of SMAs with historical cores, where the extent of subsurface contamination is vertically unbounded (did not "tag bottom" with a confirmed chemical concentration at depth below RALs), new PDI cores were located in the general vicinity of these RI stations (re-occupied station) to identify the vertical extent of contamination. As stated in the ROD, contamination in the subsurface sediment was identified as deep as 17 ft below mudline (bml) in the navigation channel and 19 ft bml in other areas (EPA 2017a).
- **No Subsurface Data**. For SMAs, especially those designated in the ROD for dredging, where no subsurface data previously existed, cores were located to define subsurface concentrations with depth in these areas. However, these small areas may be contouring artifacts within the geographic information system (GIS) program and may not represent actual areas of subsurface contamination. These areas will be reviewed in more detail and

discussed with EPA prior to starting field work, to determine if a core is necessary in these isolated areas.

- **Nearshore Data Coverage.** For portions of SMAs with limited near-shoreline shallow cores, or no cores, PDI cores were placed in nearshore areas to provide spatial coverage towards shore for large dredging footprints, where no subsurface data exists. In the shallow region, the maximum depth of contamination was estimated to be 3.5 ft bml (EPA 2017a). Six ft depths are targeted for these nearshore (shallow) areas.
- Cores were not located in areas where remedial caps have already been placed or in the RM 11E early action area where additional subsurface data have already been collected in the last few years and remedial design negotiations are currently underway between EPA and the RM 11E Group. Figure 2e includes the approximate footprint of the RM 11E early action area.

With respect to elevations and depths bml, the ROD describes three Site regions: 1) the navigation channel and FMD areas;~~,~~ 2) the intermediate region (outside the navigation channel and FMD areas to -2 ft CRD [about +3 ft NAVD88]);~~,~~ and 3) the shallow region (shoreward of -2 ft CRD). The ROD indicates sediment with concentrations above the RALs will be dredged to at least 5 ft bml, where practicable. For the navigation channel/FMD and intermediate region, deep cores will be advanced 10 to 20 ft bml depending on the estimated vertical extent of contamination in a SMA; these cores are referred to as deep cores because they are generally located in deeper water compared to the nearshore cores. For the shallow region, cores located in the nearshore area will be advanced to a depth of 6 ft bml; these cores are referred to as nearshore cores. Deep core intervals (0 to 20 ft bml) may be collected and archived at 1 ft sample intervals from the area expected to be the bottom of contamination. The bottom 2 ft section of retained sediment from each core will also be archived regardless of the target depth. Archiving will be completed in accordance with RI Round 2 FSP (Integral 2004).~~Deeper depth intervals will be archived.~~

A fourth region, the riverbank region (defined as the "top of bank down to the river" in the ROD) is not included in this PDI study. The riverbank region will be addressed on a site-specific basis by EPA as part of PHSS remedial activities or Oregon Department of Environmental Quality under source control. This PDI study is focused in areas below the shoreline defined generally as the mean high water (~~[~~MHW)~~]~~ (8 ft CRD, which is equal to about +13 ft NAVD88).

2.2.1 Example Cross Sections

Cross sections of four large SMAs were developed to help illustrate core location selection rationale (Figures 4a through 4d). Cross sections were drawn for SMAs with six or more PDI cores and large Alt F Mod active remedial footprints. Each cross section shows a mudline elevation bathymetry contour, historical RI surface sediment grabs and subsurface core locations, total PCB and total PAH concentration data (horizontally and vertically), and proposed PDI core locations. Areas with steeper slopes show two mudline bathymetry contour lines: a nearshore line and a toe of slope line. Figures 4a through 4d show bathymetry contours that follow a set elevation datum (i.e., CRD 2009) in the upper panel; the cross sections, with an associated mudline, are used to project artifacts on a set plane in space in the lower panel. The cross-section figures are summarized below, and a core-by-core rationale is provided in Table 1.

- In Figure 4a (section A-A' RM 1.9 to RM 2.7), the cross section illustrates the limited subsurface data at the downstream end of the SMA (RM 2) and at the upstream end (RM 2.5); three cores are proposed in these areas. In the middle of the SMA (RM 2.3), PCB RAL exceedances extend to the bottom of the PDI cores (depth of contamination is vertically unbounded); four cores are proposed to fill this area. The last proposed core (RM 2) is located as a result of data greater than 300 ft apart and have varying depths of contamination between existing data.
- In Figure 4b (section B-B' International Slip), a total of seven cores are planned. Four PDI cores are located in areas with less dense historical sampling in the mouth and middle portions of the slip where contaminant thicknesses vary. Three additional PDI cores will confirm the vertical depth of contamination near the head of the slip, as a result of historical cores vertically unbounded. The step-wise mudline contours of previously dredged areas are also visible in Figure 3b.
- In Figure 4c (section C-C' RM 6.8 to RM 7.5), large remedial dredging areas are identified in the downstream shallow areas where cores are limited, and those that exist are vertically unbounded (depth of contamination is not confirmed). The upstream area has several RI cores that are vertically unbounded at depth for total PCBs. The proposed PDI cores in the downstream area will provide spatial coverage of the vertical extent of contamination. The two upstream PDI cores are intended to confirm the vertical depth of contamination; this SMA has PAH and D/F exceedances vertically unbounded.
- In Figure 4d (section D-D' Swan Island Lagoon), ~~seven~~ ~~ten~~10 PDI cores are proposed over the length of the lagoon for spatial coverage, and four of seven cores near the head of the lagoon are intended to confirm the vertical extent of PCB contamination exceeding RALs (some of the historical cores are vertically unbounded).

2.2.2 Sample Types, Locations, Depths

Subsurface sediment cores will be collected across the Site between RM 1.9 and RM 11.8 based on the rationale described in Section 2.2.1. Proposed locations are presented ~~on~~in Figures 2a through 2e. Subsurface sediment samples from shallow (nearshore) cores will vary in target collection depth from 0 to 6 ft for (shallow nearshore region) and from 0 to 20 ft target depth for the deep cores (navigation channel/FMD and intermediate region). Most of the deep cores will be driven 15 ft bml or until refusal. Core locations may be modified based on the bathymetry, surface sediment sampling work, contouring artifacts, or other additional information with EPA approval. The communication strategy with EPA will follow Section 2 of the QAPP (AECOM and Geosyntec 2018a). Table 1 presents the location, core depths, location identification numbers (IDs), and rationale for subsurface sediment location selection based on the criteria described above.

Subsurface core samples will be visually logged and processed at 2 ft continuous intervals (based on the recovered depth) along the entire length of the accepted core, unless core stratigraphy indicates otherwise (see discussion in Section 4.4). The minimum sample interval will be 1 ft thickness of actual core ~~Subsurface core samples will be visually logged and processed at 2 ft intervals (continuous intervals) along the entire length of the accepted core, unless core stratigraphy indicates otherwise (see discussion in Section 4.4). The~~material. The first sample will be collected from the 0 to 2 ft interval, regardless of stratigraphy. One ft sample intervals may be collected and archived from the area expected to be the bottom of contamination, to potentially provide a refined depth of contamination. The very bottom 2 ft interval of retained sediment from the core, ~~regardless of the bottom sample interval thickness,~~ will also be processed and archived, pending results of the upper intervals (especially for the nearshore cores).

Subsurface sample counts and selected analytes are presented in Table 2. The 60 deep cores will be collocated with PDI surface sediment grab locations collected from the 0 to 30 centimeter (0 to 1 ft) interval. Proposed subsurface core station IDs, mudline elevations, and coordinates are presented in Table 3. Figure 2 presents the proposed core locations within the Site. Core location and sample IDs will correspond with the surface sediment station ID; therefore, the core station IDs will not be numerically sequential.

2.2.3 Sample Nomenclature

The sample identification scheme for subsurface sediment sample collection will utilize a three-letter project identification code followed by a ~~three~~two-letter sample matrix code, unique station code, and sample depth interval. See Section 4.2 and Table 4 in the project QAPP (AECOM and Geosyntec 2018a) for details. In summary, the identification scheme follows:

- Project phase (PDI).
- Sample matrix (SC [sediment core]).
- Unique, sequential station number (S001 to S263). Station numbers are based on placement within the location of the river (from downstream to upstream). Surface sediment grabs (non-random) and cores are all grouped together for numbering purposes.~~Station numbers are based on placement within the location of the river (from downstream to upstream). Collocated sediment grabs and cores (non-random) are all grouped together for numbering purposes.~~
- Sample interval depth (2 ft up to 20 ft).

For example, a subsurface sediment core at station 10 collected from a recovered depth interval of 6 to 8 ft would have the sample ID PDI-SC-S010-6to8. See Section 4.2.1.2 of the QAPP for nomenclature associated with field duplicates and other ~~quality assurance (~~QA~~)~~/~~quality control (~~QC~~)~~ samples. Additional data fields that describe each unique sample and core location will be recorded in the field forms and will be included in the project database, as described in the project Data Quality Management Plan (DQMP) (AECOM and Geosyntec 2018b). These may include, for example, core recovery, *in situ* sample depth, recovered sample depth, mudline elevation, RM, SMA ID, and collection method.

2.3 Sampling Schedule

Subsurface sediment coring is targeted for the second and third quarters of 2018 (beginning ~~May/June~~July), after the surface sediment sampling and bathymetry survey have been completed, and before fish tissue sampling begins in July/August 2018. Subsurface sediment coring is expected to last 3 weeks using two sampling vessels (one vessel for deep coring and another vessel for the nearshore coring). After 2 weeks into the coring program, field progress will be assessed, and if it appears that the sampling effort is behind schedule, a third vessel and crew will likely be mobilized to complete the coring in the targeted sampling period.

2.4 Key Changes from Previously Approved RI FSPs

Subsurface sediment coring will be performed in accordance with RI project plans (Integral 2002, 2004, and 2006), except as noted in the bullets below and Section 4. SOPs from the RI will be made readily available as hard copies and PDFs on SharePoint for field staff to reference before and during field work. Key PDI changes from the RI Round 2 FSP – Sediment Sampling and Benthic Toxicity Testing (Integral 2004) include the following:

- Subsurface sediment samples will only be analyzed for the focused COCs (PCB Aroclors, PAHs, D/F, DDx), grain size, total solids, and total organic carbon (TOC). If a sample is determined to contain greater than 50% fines, then it may be submitted for additional geotechnical properties using Atterberg Limits test (American Society for Testing and Materials [ASTM] D4318). The PDI study will target about 10 to 20 samples for testing with spatial coverage of the Site (one or two per river mile or per segment) and vertical coverage in the subsurface (2 to 4 ft depth, and 4 to 6 ft depth).~~A portion of the fine-grained samples may be submitted for additional geotechnical properties using Atterberg Limits test (ASTM D4318).~~
- The SOP from the RI described several different coring methods; the PDI study is intending to use a vibracore, but may consider other equipment (piston core, high frequency impact core or other device) for difficult areas that previously hit refusal (e.g., gravel) or areas with potential non-aqueous phase liquid (NAPL) (near RM 6 and RM 7 west) to help better refine the extent of NAPL.
- In areas with potential NAPL, a jar sheen test and Field Description Key will be used during core processing (See Appendix A for Field Description Key and Appendix B-1 for Jar Sheen test). When coring in areas with potential NAPL, sorbent booms and pads may

be proactively deployed around the coring area and the coring equipment/vessels to minimize dispersion of NAPL sheens that may appear on the water surface.

Cores will be processed for analytical testing at 2 ft intervals, unless stratigraphy indicates otherwise, consistent with the RI and described in the 2004 Round 2 RI sediment FSP (see RI Sections 2.2.2 and 4.6.3 and Appendix E); relevant portions of these plans have been excerpted from the RI and included in Appendix B-2 of this FSP.~~Subsurface sediment cores will be processed for analytical testing at 2 ft intervals, unless strong stratigraphy indicates otherwise; the RI discussed sample thickness ranging from 1 to 4 ft.~~ Stratigraphy changes may include a major observational change in the two dominant grain sizes, depositional regime, or presence/absence of anthropogenic material/indicators such as sheen, NAPL, or debris."

3. PROJECT ORGANIZATION/FIELD TEAM

3.1 Team Organization and Responsibilities

Team organization is detailed in the PDI Work Plan and in Section 2 of the QAPP (AECOM and Geosyntec 2018a). As it relates to this FSP, AECOM and Geosyntec are coordinating activities including management of all subcontractors, field sampling, analysis, and reporting scoping tasks. The PDI Project Coordinator, Mr. Ken Tyrrell, and PDI Project Manager, Dr. Jennifer Pretare, Ph.D. (AECOM), will be responsible for overall project coordination and providing oversight on all project deliverables. Ms. Anne Fitzpatrick (Geosyntec) is the senior technical lead for this task. Ms. Nicky Moody (AECOM) and Mr. Keith Kroeger (Geosyntec) will be the Field Coordinators (FCs) and will be generally responsible for general field QA/QC oversight. The project chemists, Ms. Julia Klens-Caprio (Geosyntec), Ms. Amy Dahl (AECOM), and Ms. Karen Mixon (AECOM), will be responsible for coordination with laboratories regarding sample volumes, logistics, schedule, detection limits and matrix interferences, and ensuring overall data quality.

Gravity Marine Services (Gravity), of Fall City, Washington, will perform vessel support, with Mr. Shawn Hinz acting as a point of contact. Analytical laboratories include ALS Environmental (ALS) in Kelso, Washington, and TestAmerica Laboratories (TestAmerica) in Fife, Washington, Sacramento, California, and Knoxville, Tennessee. Additional coring contractors and equipment may be mobilized if needed, to improve core recoveries in difficult areas (e.g., refusal, large wood debris, gravel, cobbles, etc.).

3.2 Communication/Information Flow

The communication strategy is outlined in Section 2 of the QAPP (AECOM and Geosyntec 2018a). The FCs, Ms. Nicky Moody (AECOM) and Mr. Keith Kroeger (Geosyntec), will be the points of contact for field staff during the implementation of this FSP. Ms. Anne Fitzpatrick

(Geosyntec) will be the senior technical lead consulting with the field staff on core placement and interpretations, as needed, for this task. Deviations from this FSP or the project-specific QAPP will be reported to the PDI Project Manager for consultation. Significant deviations from the FSP/QAPP will be further reported to representatives of the Pre-RD AOC Group and EPA by the PDI Project Coordinator.

3.3 Coordination with EPA

The PDI Project Coordinator will notify the EPA Project Manager 1 to 2 weeks prior to beginning any field activities so that EPA can schedule any oversight activities required. The PDI Project Coordinator will also notify the EPA Project Manager once field activities have been completed.

Split samples for chemical analyses can be provided to EPA upon its request. EPA's Project Manager should contact the PDI Project Coordinator to coordinate this activity and determine appropriate logistics. If EPA elects to collect split samples, collection at stations where ~~blind~~ field duplicates are taken is recommended so that EPA's comparison samples can be evaluated relative to the field and analytical variability measured by the project team.

4. SAMPLE COLLECTION PROCEDURES

The following sections describe the procedures and methods that will be used during subsurface sediment sampling in accordance with the project QAPP, and previously approved FSPs and SOPs from the RI for methods. These procedures include health and safety procedures, sampling methods; recordkeeping; sample handling, storage, and shipping; and field quality control. All field sampling activities will follow procedures outlined in the project Health and Safety Plan (AECOM and Geosyntec 2018c).

4.1 Sampling Vessels and Equipment

Gravity will provide vessels and a Vibratory Core Tube Driver (vibracore) system to conduct subsurface sediment coring. Vibracore tubes will be advanced to various lengths as discussed in Section 2.2.2. Vibracore tubes will be sectioned on the vessel platform into transportable sizes (approximately 4 ft) and transported by vehicle to the AECOM Sample Processing Facility for processing. Core tubes will be kept upright to the extent practicable until processing.

Gravity will perform the coring activities utilizing two sampling vessels, R/V *Cayuse* and R/V *Tieton*, each vessel equipped with a model RIC-5500 vibracore system manufactured by Gravity ~~Marine~~. The RIC-5500 corer unit uses an electric motor to produce an adjustable 3,500 to 6,500 feet per pounds (ft/lbs) of impact force at a frequency of 1,500 vibrations per minute. The system is contained in a seafloor frame with legs. The RIC system will accept core tubes up to 10 meters in length and includes an active suction check valve adapter that mounts to the vibratory head for easy swap-out on deck. A power cable will be used to deploy the system, which includes surface power on the deck of the vessel and data/controls.

Both vessels contain a virtual anchoring system that incorporates autopilot and two small motors to keep the vessel on station without needing to set fixed anchors. The R/V *Cayuse* is a 26 ft research vessel with landing craft design, crew cabin, wash-down hose, and working area. The R/V *Tieton* is a 34 ft research vessel with landing craft design and crew cabin, pilot house, and working area. Both vessels have an A-frame with custom research winch and dynamic positioning system. A minimum of 4-~~inch~~ inch-~~([in])~~ diameter Lexan (preferred) or aluminum core tubes and custom core catchers will be used for core collection. Lexan core liners are sturdier and do not bend as easily compared to plastic sample liners; therefore, Lexan sample liners will be used in areas where compacted sediments and/or cobbles/debris are expected. A mechanical piston corer may be used when continued refusal or inadequate recovery is experienced. Core tubes can be adapted with an internal, mechanical piston-type device to improve core recoveries, if needed. Both of these vessels and their coring equipment have been previously used on the lower Willamette River.

Alternative vessels are available and can provide additional or backup support for in-water sampling as needed. All vessels will be moored within Swan Island Lagoon and mobilized from Swan Island public boat launch.

Additional equipment needed for coring and sample processing equipment are identified on the equipment checklist in Appendix A-1. Sample containers and preservatives, as well as coolers and packing material, will be supplied by the analytical laboratory.

4.2 Station Positioning and Vertical Control

Station positioning and vertical control will be performed ~~-~~as outlined in detail in the attached SOP (Appendix B-3)~~consistent with the RI Round 1 FSP (Integral 2002~~). A differential global positioning system (DGPS) unit will be used on the vibracore A-frame to confirm the horizontal sampling locations to an accuracy of 1 to 2 meters, consistent with the RI. The DGPS accuracy will be confirmed each morning ~~and evening to a known land-based survey point~~at the PH-1 benchmark installed at the Swan Island boat launch for the project (see GPS station log in Appendix B-3). Confirmed station~~s~~ locations will be recorded to the nearest whole foot in North American Datum of ~~(NAD)~~ 1983 National Adjustment of 2011 ~~, (~~NAD83 ~~(~~[2011]), State Plane Coordinate System (SPCS) Oregon North Zone, International Feet~~State Plane North datum~~.

Vertical control will be established using an on-board fathometer or lead line to measure depth to mudline at core locations at the time of collection. The fathometer accuracy will be checked regularly by vessel contractor (Gravity) and calibrated when necessary following ASTM D6318 Standard Practice for Calibrating a Fathometer Using a Bar Check Method or other similar practice. Water depths will be converted to mudline elevations in ft NAVD88 based on ~~the river stage at the time of sampling as recorded at the Morrison Street Bridge located at RM 12.7~~synchronizing timestamped gauge data downloaded from the Northwest River Forecast

Center for gauge PRT03, located near RM 12.8. As described in Appendix B-3, this river stage gauge data are reported in the Columbia River Datum (CRD), so a correction will be needed to convert to NAVD88. The vertical CRD will also be recorded. Water levels will be recorded to the nearest one tenth of a foot in the datum specified in the DQMP (AECOM and Geosyntec 2018b). Further details regarding station positioning and vertical controls are provided in Section 5.2 of Integral (2002).

4.3 Core Collection and Processing

Subsurface core sample collection will be performed as described in the RI Round 2 FSP, Section 4.0 (Integral 2004). In general, coring will follow these steps:

1. Subsurface sediment core collection:
    a. Core tube caps will be removed immediately prior to placement into coring device, in order to minimize potential core contamination.
    b. Position will be recorded when the vibracore first rests on the sediment surface.
    c. The vibracore will be advanced without power (under its own weight), then vibration will be applied until the core tube is advanced to the target depth or refusal.
    d. After a brief pause, the core tube will be extracted from the sediment using only the minimum vibratory power needed for extraction.
    e. As soon as the core tube daylights to the surface water/air interface, a bottom cap will be placed over the tube to prevent material loss out of the core catcher.
    f. Inspect the exterior side-walls of core tube for signs of potential NAPL and scrapes/scoring of the aluminum walls from contact with dense gravel. If NAPL is suspected, then take appropriate field precautions as described in the RI FSPs and Appendix B-1.
    g. The following core collection data will be recorded on the vessel (in the core collection log [Appendix A-2]):
        i. Date/Time. Local date and time when the vibracoring began at each station.
        ii. Depth to Mudline. Water depth at the sampling station at the time of core collection.
        iii. Total Drive Length. Core tube length and depth of the core tube penetration into the subsurface.
        iv. Recovered Length. Thickness of the sediment column retained in the core tube prior to sectioning and removal of the core catcher.

    v. Sediment Observation. Average grain size, color, notable odors, debris, etc. observed at each of the cut ends of the core section. Visual description will follow ~~American Society for Testing and Materials (~~ASTM~~)~~ visual-soil classification procedure.

   h. Core will be accepted, rejected, or stored on the vessel pending another drive attempt. If a core sample does not meet the core acceptance criteria, then field protocols will be followed as described in Section 4.4 of this FSP.

   i. After core acceptance, water will be carefully decanted from the top of the core tube to minimize sediment disturbance. Cores will be cut into segments approximately 4 ft long for handling, storage, and transport. Core tubes will be capped with aluminum foil and plastic caps, scribed on the sidewalls with core and segment ID (A, B, C, etc.) and "up" arrow, stored upright with ice, then transferred upright from the sampling vessel to the AECOM Sample Processing Facility, and stored upright in refrigerators until processed.

2. Core Acceptance Criteria: each subsurface sediment core retrieved on deck will be compared to these acceptance criteria:

   a. Overlying water is present and the surface is intact.

   b. Core has at least 80% recovery versus penetration.

   c. Core tube is in good condition (not excessively bent).

   d. Core appears representative of surrounding area.

   e. Target penetration depth has been achieved or bedrock is encountered. If target depth is not reached due to cobbles, debris, refusal, or other difficult drilling conditions, ~~then~~ an additional core will be attempted as described in the contingency plan (see Section 4.3.1). If NAPL is observed at depth in a core, then EPA will be notified.~~Target penetration depth has been achieved (within +/- 2 ft of target).~~

4.3.1 Contingency Plan for Field Condition Impediments for Collecting Cores~~:~~

During the subsurface sediment coring efforts, the field crew may encounter field conditions that preclude collection of acceptable cores at the planned location (e.g., limited access, poor recovery, safety concerns, debris/rock/bedrock causing refusal). No more than three attempts will be made to relocate the core within a 25-~~-~~ft radius of the planned location.[2] If the first core attempt meets the acceptance ~~acceptable~~ criteria, then no additional cores will be collected at that station. If not, the cores from each attempt will be retained until an acceptable core (as defined

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[2] Distances proposed in this FSP were based on previous sediment project experience in EPA Region 10.

above) is acquired; if an acceptable core cannot be obtained within a ~~30~~ 25 ft radius, then the best of three attempts will be retained and processed. If recovery is poor for all three attempts (< 60% recovery) or the area within ~~30~~ 25 ft is inaccessible, then core drives will be attempted from a larger radius (e.g., 50 ft radius) following discussions with the PDI Project Manager. If an acceptable core cannot be obtained from within a 50 ft radius, attempts may be made further from the target location in coordination with EPA.

If utilities run within 15 feet of a proposed coring location based on review of ~~geographic information system (~~GIS~~)~~ maps and confirmed in the field with ~~'~~"utility crossing~~'~~" signage, then the coring location will be adjusted a minimum of 15 feet (using best professional judgement) and noted in the field notebook.

4.4 Core and Sample Processing

Subsurface sediment core processing at the field laboratory will follow these steps:

1. The AECOM Sample Processing Facility is at 1116 SE Caruthers Street, Portland, Oregon (phone #: 503-239-5884). The facility is approximately 20 blocks from the field site and will be used as a base for staging work, sample processing, sample/equipment storage, sample packaging and shipping, daily field team meetings, decontamination supplies, and other support needs (Figure 1).
2. The core tube will be split open to preserve the material stratigraphy inside the core tube ~~Cores will be opened~~ using a table saw, hand-held circular saw, shearing tool, or similar device~~when possible~~, according to methods described in RI Round 2 FSP (Integral 2004).
3. A photoionization detector (PID) will be used for pre-screening of each core. As soon as the core is split open, the PID monitor will be held in the ambient air space just above the open core and slowly moved down the core from top to bottom. PID readings will be recorded in the field notebook. If there is a "PID hit" or if sheens/petroleum-like odors are suspected, then a headspace screening will be conducted following procedures described in the RI Round 2 FSP (Integral 2004) Section 4.6.4, ~~f~~Field ~~s~~Screening; this section has been excerpted from the RI and included in Appendix B~~-~~4 of this FSP. PID calibration will follow manufacturer's instructions.
4. ~~3.~~4. Sediment cores will be visually described following ASTM D-2488 Standard Practice for Identification of Soils (Visual-Manual Procedure~~,~~)~~;~~ ASTM D-2488~~)~~)~~visual soil classification procedures~~. A logging key of the visual classification method is provided in ~~(~~Appendix A-3~~)~~.
5. ~~4.~~5. If potential NAPL is observed, then a jar sheen test or other device will be used over the suspected NAPL interval to further estimate (qualitatively) the presence of NAPL; see SOP in Appendix B-1. Appendix B-1 also provides visual descriptors for residual or free-phase NAPL observations.
6. ~~5.~~6. A hand-held field torvane will be used to measure shear strength and pocket penetrometer to measure compressive strength within each sample interval. Manufacturers instructions

for each field parameter tool will be followed regarding use and calibration of field equipment.

~~6.~~7. Subsurface sample intervals will be 2 ft intervals unless lithology indicates otherwise. Minimum interval thickness will be 1 ft. Maximum ~~thickess~~thickness will be about 3 ft in general accordance with thickness criteria in RI Round 2 FSP (Integral 2004).[3]

~~7.~~8. Cores will be photographed and archived per the RI Round 2 FSP (Integral 2004).

After the cores have been described and the sample intervals have been determined, sediment will be collected and homogenized within the determined sample interval until uniform in color and texture and placed into appropriate sample containers for laboratory analysis.

~~.Headspace screening using a photoionization detector (PID) will be conducted over the core sediment.~~

~~8.~~9. Core lithology, geotechnical indexes, PID readings, sample IDs, and sample depth intervals will be recorded in the core processing log (Appendix A-2).

SOPs from the RI will be followed. These SOPs are from Appendix F~~E~~ of the RI FSP for Round 2 (Integral 2004) and are consistent with Appendix D of the RI FSP for Round 3 (Integral 2006). Relevant SOPs have been excerpted from the RI and included in Appendix B-2 of this FSP. These SOPs include lists of supplies and equipment, equipment decontamination, core collection, subsurface sediment sample processing, chain-of-custody, and packaging and shipping samples. The SOPs will be available in hard copy and on the project SharePoint site for easy access by the field crews.

4.5 Sample Handling and Transport

Chain-of-custody procedures will be followed as detailed in the RI Round 2 FSP (Integral 2004) Section 4.8. Samples will be stored on ice at 40 to 6 degrees Celsius (°C) in a field cooler and shipped to appropriate laboratories as detailed in the RI Round 2 FSP (Integral 2004). Sections 4.8.1 and 4.8.2 of the RI Round 2 FSP along with the SOPs in Appendix E of the RI FSP for Round 2 (Integral 2004) and Appendix D of the RI FSP for Round 3 (Integral 2006) provide additional details on custody, storage, and shipping details, respectively. Additional details are provided in Section 4.3 of the QAPP (AECOM and Geosyntec 2018a).

[3] The RI Round 2 FSP discussed a range of 1 to 4 ft sample thickness. However, a goal of the PDI study is to refine contaminant depths, so in general, target thicknesses are much less than 4 ft (2 ft target).

4.6 Field Logbook and Forms

All field activities will be recorded in a field logbook as outlined in detail in Section 4.3 of the RI Round 2 FSP (Integral 2004). Field forms (Appendix A-2 of this FSP) will be completed as outlined in detail in the RI Round 2 FSP (Integral 2004).

4.7 Decontamination Procedures

Decontamination procedures for all non-dedicated (reusable) sampling equipment (bowls, spoons, etc.) will follow methods detailed in the RI Round 2 FSP Appendix E Sediment Sampling SOP (Integral 2004). This SOP is consistent with the RI Round 3 FSP Appendix D Sediment Sampling SOP (Integral 2006). In summary, non-dedicated sampling equipment decontamination steps will include an initial rinse with vessel river water to dislodge particles, a scrub with brush and Alconox™ or other phosphate-free detergent, and then a rinse with deionized water. Additional rinses with nitric acid or methanol are not anticipated but may be considered based on sample conditions (e.g., excessive oily/tar residue). Rinses using nitric acid or methanol, if used, will be handled and disposed of according to RI Round 2 FSP Appendix F SOP. Sampling spoons and bowls will be covered with aluminum foil until use (dull side down). Gloves will be replaced before and after handling each sample to minimize sample contamination. Core tubes and core cutter heads will be washed in a similar manner.

4.8 Investigation-Derived Waste Disposal

Investigation-derived waste (IDW) disposal will occur as described in the ~~RI Round 1 FSP (Integral 2002, see Section 5.7)~~Management of IDW SOP (Appendix B-5). In general, any excess water or sediment remaining after processing core collection and sectioning will be returned to the vicinity of the collection site. No excess sediment containing NAPL principal threat waste will be returned to the vicinity of the collection site; see IDW SOP in Appendix B-5 of this FSP. Any water or sediment spilled on the deck of the sampling vessel will be washed into the surface waters at the collection site before proceeding to the next station. Phosphate-free, detergent-bearing liquid wastes from decontamination of the core sampling equipment will be washed overboard or disposed into the sanitary sewer system. Waste solvent rinses, if needed, will be held in sealed plastic buckets and disposed of into the sanitary sewer.

Tyvek, gloves, paper towels, plastic sheeting, and other waste material generated during sampling will be placed in heavyweight garbage bags or other appropriate containers and placed in normal refuse containers for disposal at a solid waste landfill. Used core tubes will be washed and then recycled. Leftover sediment after core processing, and oily or other potentially contaminated IDW will be placed in appropriate containers, characterized for disposal, and disposed of at an appropriate EPA-approved waste facility.

4.9 Field Quality Control

Field QC samples are collected to assess variability within samples (e.g., duplicates), to evaluate if potential sources of sample contamination are present (e.g., rinsate and trip blanks), or to confirm proper storage conditions of samples (e.g., temperature blanks). All QA/QC procedures are detailed in the project QAPP. Requirements for field QC samples are provided in Table 4, and a summary of all field QC sample numbers is provided in Table 5. ~~Blind f~~Field duplicates and other field QC samples, such as trip blanks, temperature blanks, and rinsate blanks, will be collected as outlined in Section 4.6.1 of the project QAPP. Rinsate blanks will be collected by pouring deionized water over the sampling spoons and core tubes after field decontamination. Rinsate blanks will be collected for each sampling vessel.

5. LABORATORY ANALYSIS

Subsurface sediment core samples will be sent to the following laboratories for physical and chemical analysis:

- ALS in Kelso, Washington, for PAHs and DDx
- TestAmerica in:
  - Fife, Washington, for PCB Aroclors, TOC, grain size, and total solids (and Atterberg Limits if selected)
  - Sacramento, California, for D/F
  - Burlington, Vermont, for Atterberg Limits

Field parameters (measured at the Sample Processing Facility) will include geotechnical index testing down the length of the core at about 2 ft intervals. Measurement tools will include a hand-held field torvane to measure shear strength and pocket penetrometer to measure strength.

Additional details on the analytical methods, QA/QC requirements and procedures, and laboratory specific QA/QC requirements are detailed in Section 4.6 of the project QAPP. All samples will be placed in laboratory-supplied sample containers and preserved according to analytical protocols. Sample containers, analytical methods, preservation requirements, holding times, and sample sizes are provided for all analyses in Table 6.

6. DATA MANAGEMENT AND REPORTING

6.1 Field Data Management

The procedures and activities outlined in this FSP are designed to ensure ~~data quality objectives~~DQOs are met. As detailed in the project QAPP, the following data management procedures will be performed in the field:

- All samples will be given a unique identifier (Section 2.2 of this FSP).
- All samples will be collected and transported under chain-of-custody control (Section 4.5 of this FSP).
- Field logbooks and data sheets will be maintained (Section 4.6 of this FSP).
- Field QA/QC samples will be collected according to the project QAPP (Section 4.9 of this FSP).

6.2 Post-Analysis Data Management and Reporting

Analytical laboratories will be required to adhere to all QA/QC procedures outlined in the project QAPP. Laboratories will provide all data for field investigations in electronic format and QA/QC reports, including a narrative of the standard QA/QC protocols. Data validation and data management will be performed according to the project QAPP and DQMP. Following data validation, all data, supplementary information, and validator qualifiers will be compiled into an SQL Server database for the project. Data summary files will be provided to EPA as they become available after data validation and database management.

Results from the implementation of this FSP will be used to support the data use objectives described in Section 1.3 of the PDI Work Plan (Geosyntec 2017: Table 5). Data summaries and evaluations will be included in the PDI Evaluation Report.

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TABLES

FIGURES

APPENDIX A

~~Soil Classification Method,~~ Equipment Checklist, ~~and~~ Field Forms, and Sediment Logging Key

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A-1. Equipment Checklist

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A-2. Field Forms

~~Portland Harbor PDI Subsurface Sediment Core Collection Log~~
~~Portland Harbor PDI Subsurface Sediment Core Processing Log~~

A-3. -Summary of the ASTM Visual-Soil Classification Method and Sediment Sample Logging Key

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~~Unified Soil Classification System – ASTM D2488~~
~~Portland Harbor PDI Sediment Sample Logging Key~~

~~Hydrocarbon Field Screening by Sheen Test SOP~~
~~Field Description Key for Potential NAPL in Sediments~~
~~Management of Investigation-Derived Waste SOP~~

APPENDIX B

Standard Operating Procedures ~~Field Forms and Checklists~~

B-1. Hydrocarbon Field Screening by Sheen Test and Field Description Key for Potential NAPL in Sediments

B-2. ~~Subsurface Sediment Sampling and Processing, from Appendix F of Round 2 FSP dated June 21, 2004~~Surface Sediment Sampling and Processing (Integral 2004)

~~Surface Sediment Sampling and Processing~~
~~Chain-of-Custody~~
~~Packing and Shipping Samples~~
~~Sediment Core Collection and Processing~~

B-3. Horizontal and Vertical Station Control

B-4. Round 2 FSP Excerpt of PID Field Screening (Integral 2004)

B-5. Management of Investigation-Derived Waste

- ~~Sediment Sampling Equipment Checklist~~
- ~~Portland Harbor PDI Subsurface Sediment Core Collection Log~~
- ~~Portland Harbor PDI Subsurface Sediment Core Processing Log~~
- ~~Portland Harbor PDI Sediment Sample Logging Key~~
- ~~Corrective Action Record~~
- ~~Field Change Request~~

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~~Chain of Custody/Laboratory Analysis Request Form~~

- ~~Unified Soil Classification System – ASTM D2488~~

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